

NASA Vision & Mission

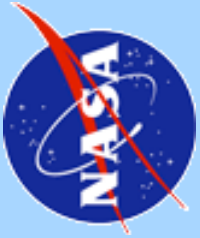
NASA vision for the future is:

- To improve life here,
- To extend life to there,
- To find life beyond

The NASA mission is:

- To understand and protect Earth
- To explore the Universe
- To inspire the next generation
- as only NASA can





Gliding Experiments of the Wright Brothers The Wrights and Flight Research

1899-1908

Al Bowers
Jennifer Hansen Cole
Cam Martin
NASA Dryden Flight Research Center

Background: The Times



Transcontinental Railroad...

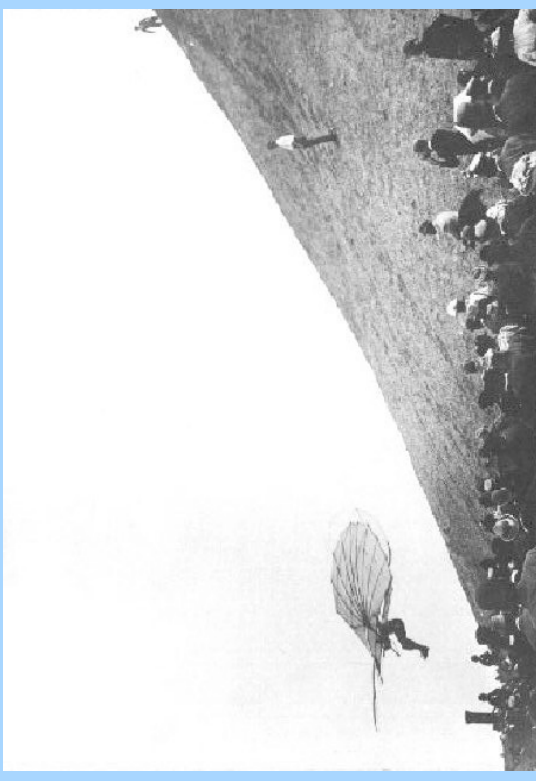
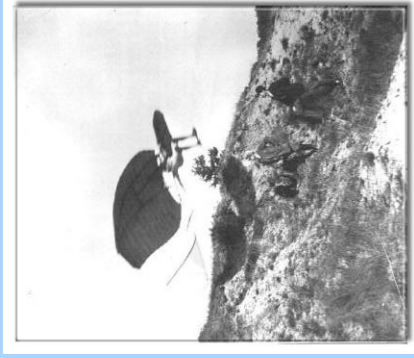
- the great engineering achievement of the time
- understanding of “two-track” vehicle systems (buggys, carts, & trains)
- completed on 10 May 1869 (Wilbur was two years old)

Background: Progenitors

- Otto Lilienthal
 - experiments from 1891 to 1896
- Samuel P Langley
 - experiments from 1891-1903
- Octave Chanute
 - experiments from 1896-1903

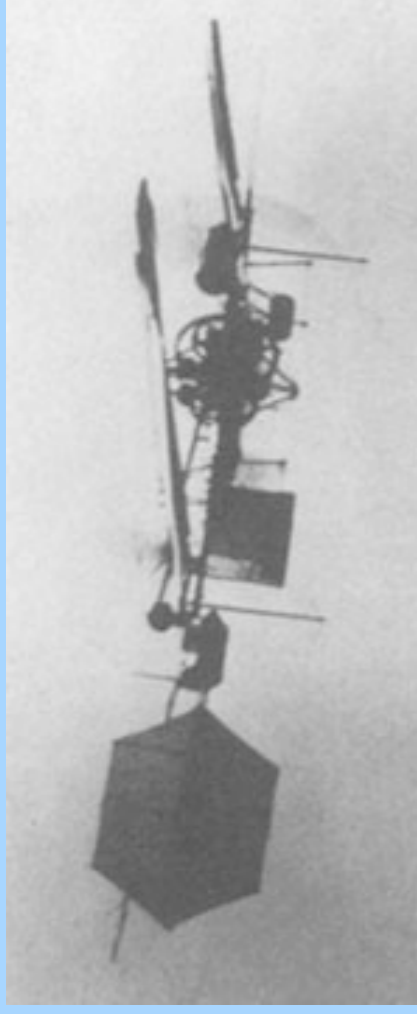
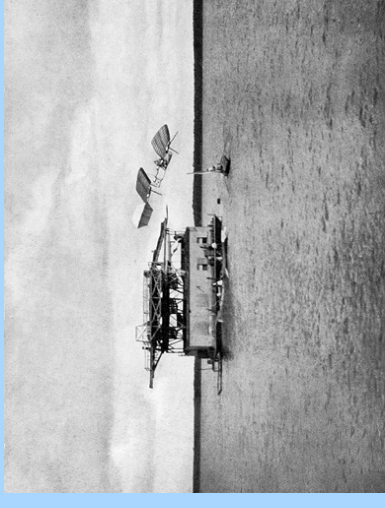
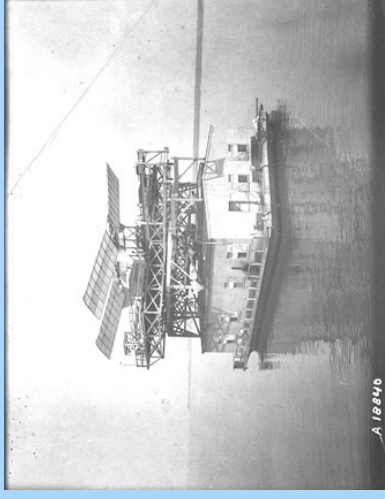
Otto Lillienthal

- Glider experiments 1891 - 1896



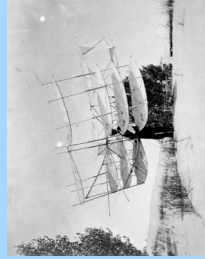
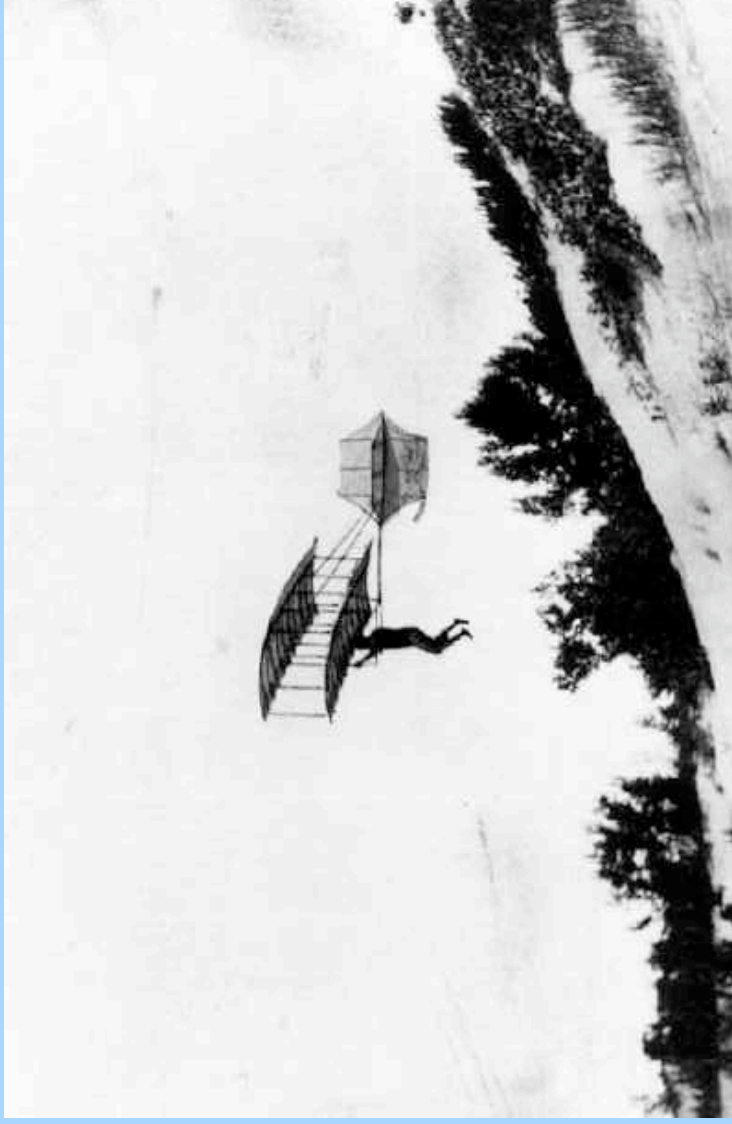
Dr Samuel Pierpont Langley

- Aerodrome experiments 1887-1903



Octave Chanute

- Gliding experiments 1896 to 1903



A Hundred Years Ago...

1905 Wright Flyer



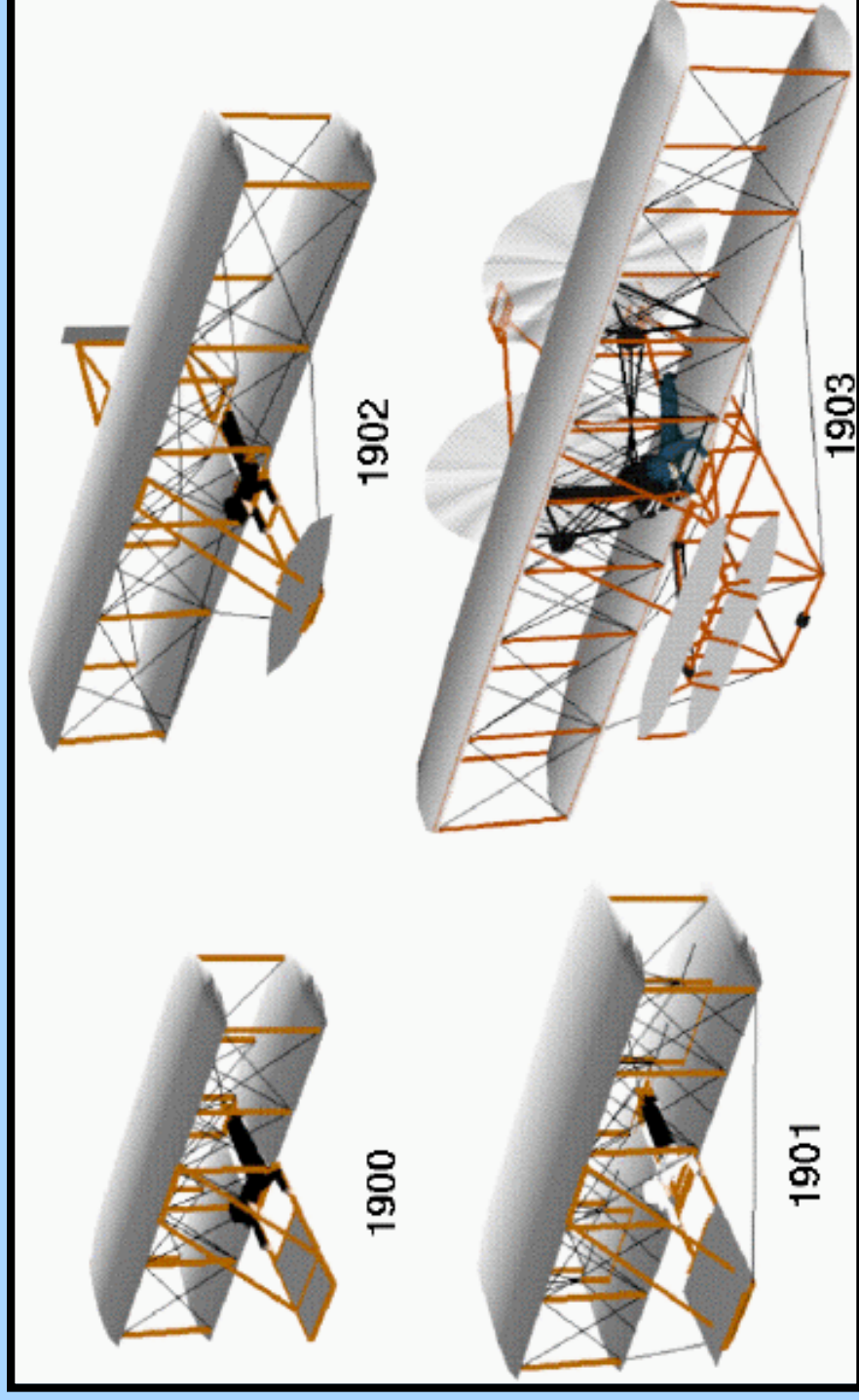
4 Oct 1905



11 May 1908

Kitty Hawk Flight Research

1900-1903



Wilbur and Orville



16 Apr 1867 – 30 May 1912



19 Aug 1871 – 30 Jan 1948

Wright Brothers Timeline

- 1878 The Wrights receive a gift of a toy *helicopter*
- 1895 The Wrights begin to manufacture their own bicycles
- 1896 The Wrights take an interest in the "flying problem"
- 1899 Wilbur devises a revolutionary control system, builds a *kite* to test it; also writes the Smithsonian.
- 1900 The Wright brothers fly a *glider* at Kitty Hawk, NC
- 1901 The Wrights fly a bigger *glider* at Kitty Hawk, NC
- 1901 In Dayton, OH, they build a research *wind tunnel*
- 1902 The Wrights perfect their *glider* and learn to fly
- 1903 The Wright brothers make the first controlled, sustained *powered flight* at Kitty Hawk.
- 1905 In Dayton, the Wrights develop a practical airplane

<h1 style="text-align: center;">WEST SIDE NEWS.</h1>	<p style="text-align: center;">DAYTON, OHIO, JULY 20, 1869</p>	<p>one unit of the way, but with a genuine interest in their growth. The old lands had all the time their wanted; and when at last they had sturdily helped the clergy, released young girls over the edge of the sea, and they showed themselves able to get about as their own heads, rather than glaze to promote the building operations and the dull form of the present, her tearing the rocks apart was heard where the birds had perched.—<i>Reverend Trimmer's</i>.</p>	<p>same is more interesting to the young people than an adventure of Tassend McKeel, one of the first settlers of Clayton. McKeel, a young man named Webster, and James T. Fisher were out one day on a moose hunt. The only gun was carried by McKeel; the two others went armed with a hatchet each.</p>	<p>As the company divided, McKeel, and kept to the base of Mt. Barry, while the others ascended it and took the shorter route. McKeel and two dogs had scaled up an old tree on the western slope of the mountain, and, after a long wait, McKeel's tent is visible of his companions to appear them of his success.</p>	<p>In the meantime, McKeel and Webster had found the lake, where the two rules of a nobleman's line, were wanted. They tried to drive them out of the den, by building</p>	<p>Vol. 1.</p> <p style="text-align: center;">West Side News.</p> <p style="text-align: center;">PUBLISHED WEEKLY.</p> <p>Vibor Wright Editor wells Wright Publisher</p> <p>TERMS:—Quarter of year, twenty cents a year, one dollar.</p> <p style="text-align: center;">1210 WEST THIRD STREET, DAYTON, OHIO.</p> <p style="text-align: center;">Racing a Bird's Nest.</p>	<p>Edna and Carlos, the inventor of the Corlies engine, in building an addition to his factory, while buying the foundation found it necessary to remove a ledge by blasting. The workmen had been employed, the materials provided, and the blasting began. The next morning Mr. Corlies passed the place where work was pro-</p>
<p>Vol. 19.</p>	<p>No. 19.</p>	<p>F. M. NIPGEN, DEALER IN DRUGS, MEDICINES Prescriptions carefully compounded.</p>	<p>W. W. Cor, Fifth and Williams</p>	<p>WM. P. GRAYBIL DEALER IN Drugs, medicines, &c. Prescriptions carefully compounded.</p>	<p>J. W. COATES, DEALER IN DRUGS, MEDICINES, AND CHEMICALS Prescriptions carefully compounded.</p>	<p>111 West Third St.</p>	<p>THE</p>

Dayton's "West Side News"

Wright Brothers' Cycle Company

- “single-track” vehicle mechanics

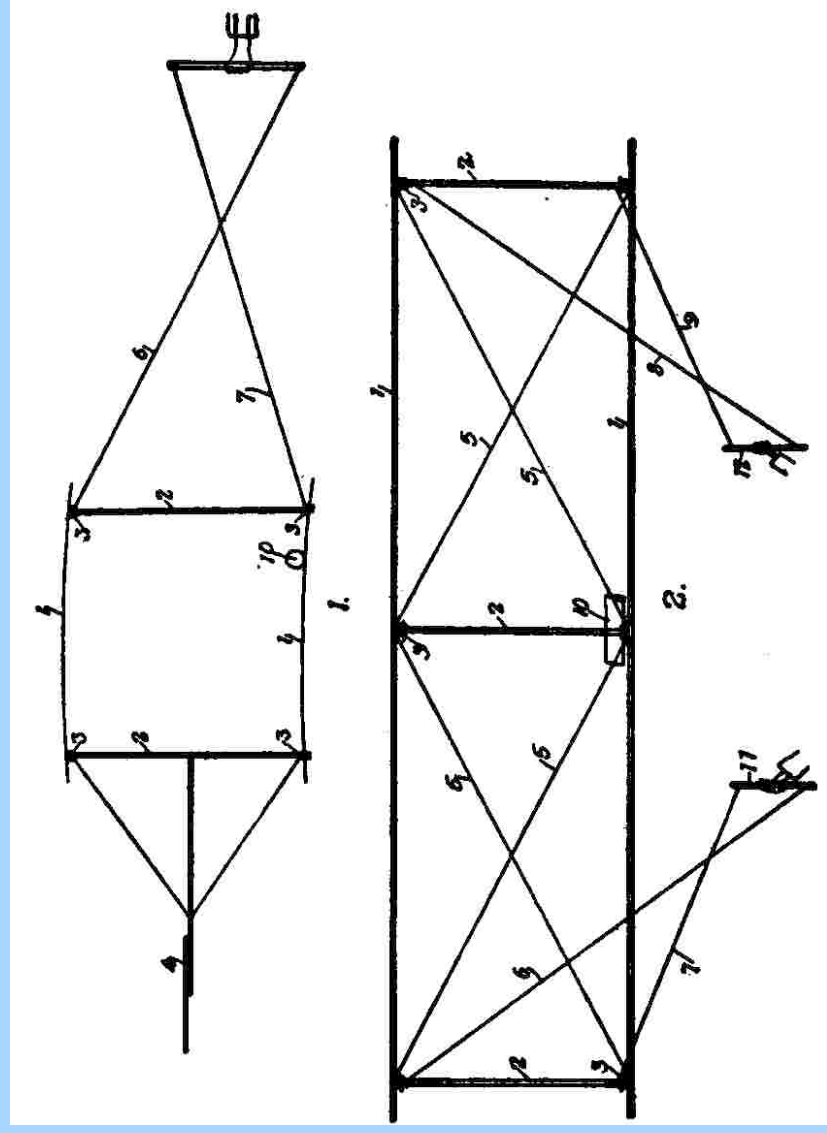
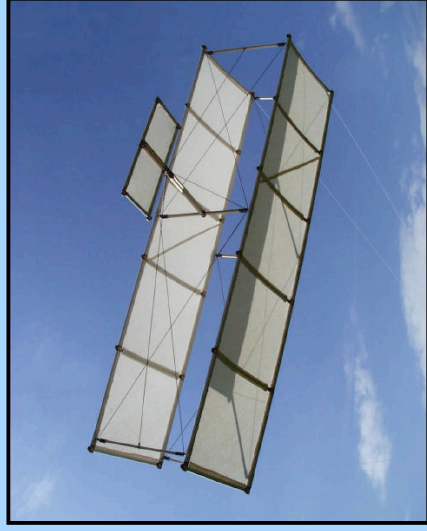


Inspiration: July 1899



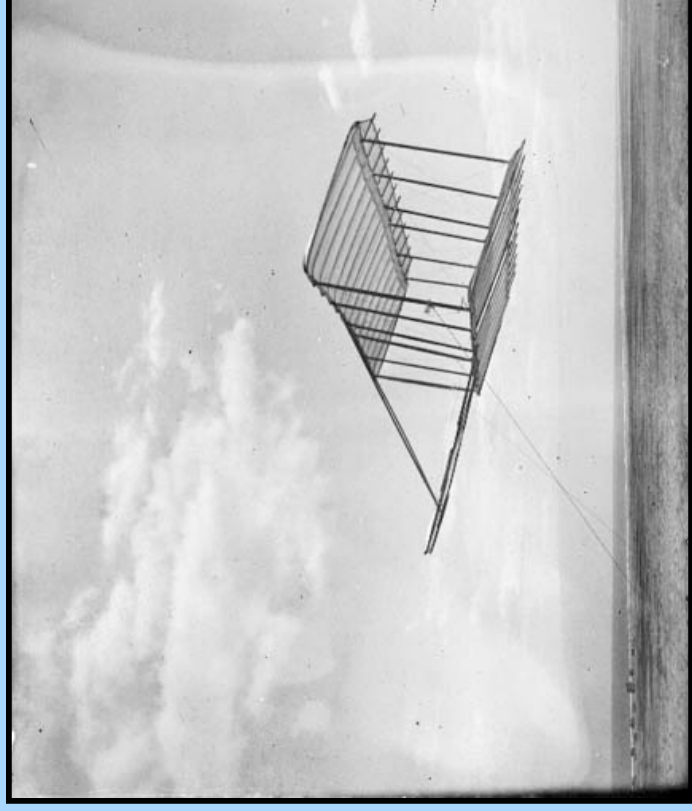
1899 Kite Experiments

Dayton Ohio



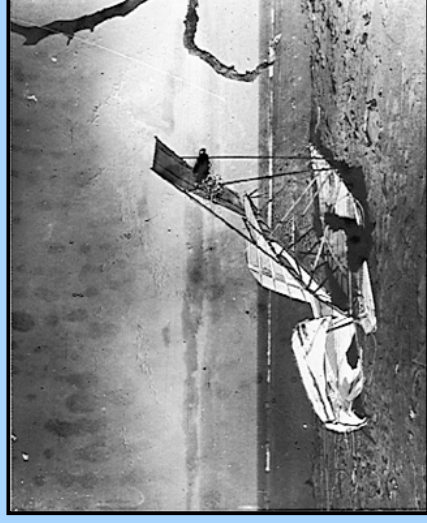
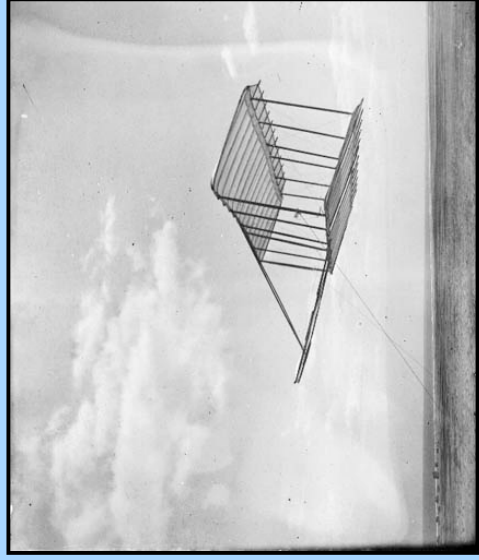
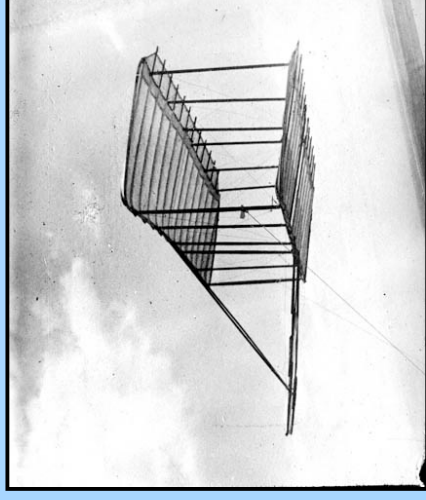
1900 Wright Glider

- Span: 17 feet
- Chord: 5 feet
- Gap: 4 feet, 8 inches
- Camber: $\frac{1}{23}$
- Wing Area: 165 sq ft
- Weight with operator
190 lb



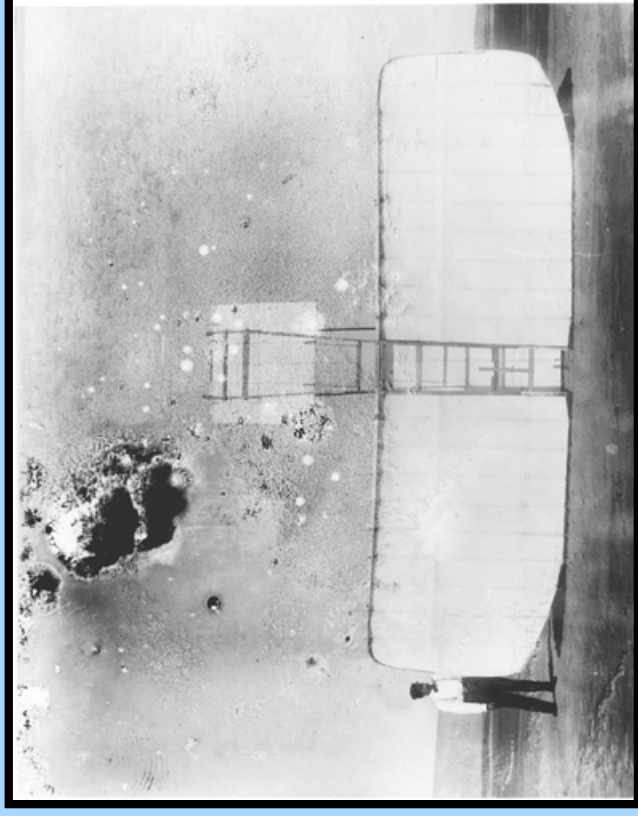
1900 Wright Glider

Kitty Hawk September - October 1900



1901 Wright Glider

- Span: 22 feet
- Chord: 7 feet
- Gap: 4 feet, 8 inches
- Camber: $1/17$
- Wing Area: 290 sq ft
- Horizontal Rudder Area
18 sq ft
- Length 14 feet
- Weight 98 lb



1901 Wright Glider

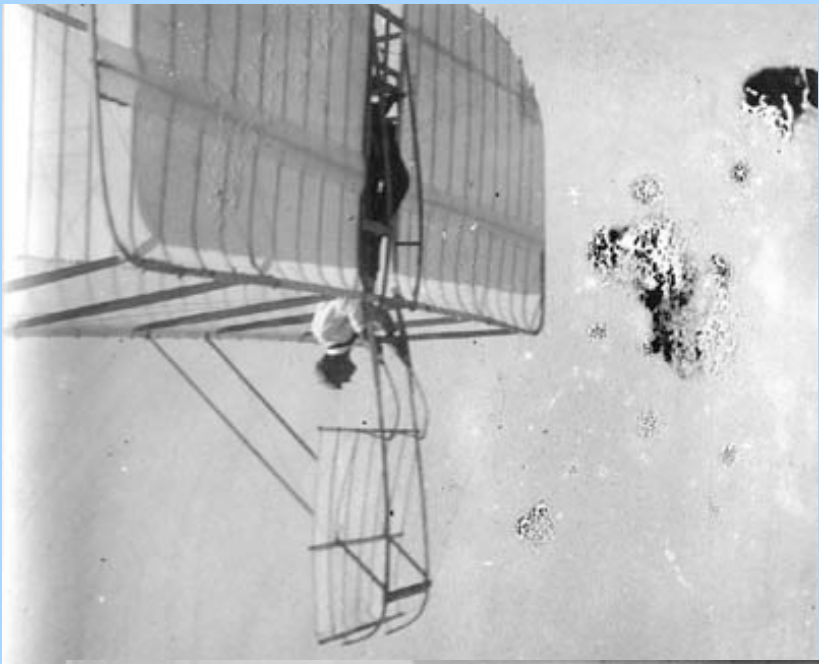
Kitty Hawk July - August 1901



1901 Glider Flown as a Kite



1901 Wright Flown as Glider



Kitty Hawk 1901



They go home, very discouraged.

**On the train back to Dayton,
Wilbur tells Orville that men would
not fly for another fifty years...**

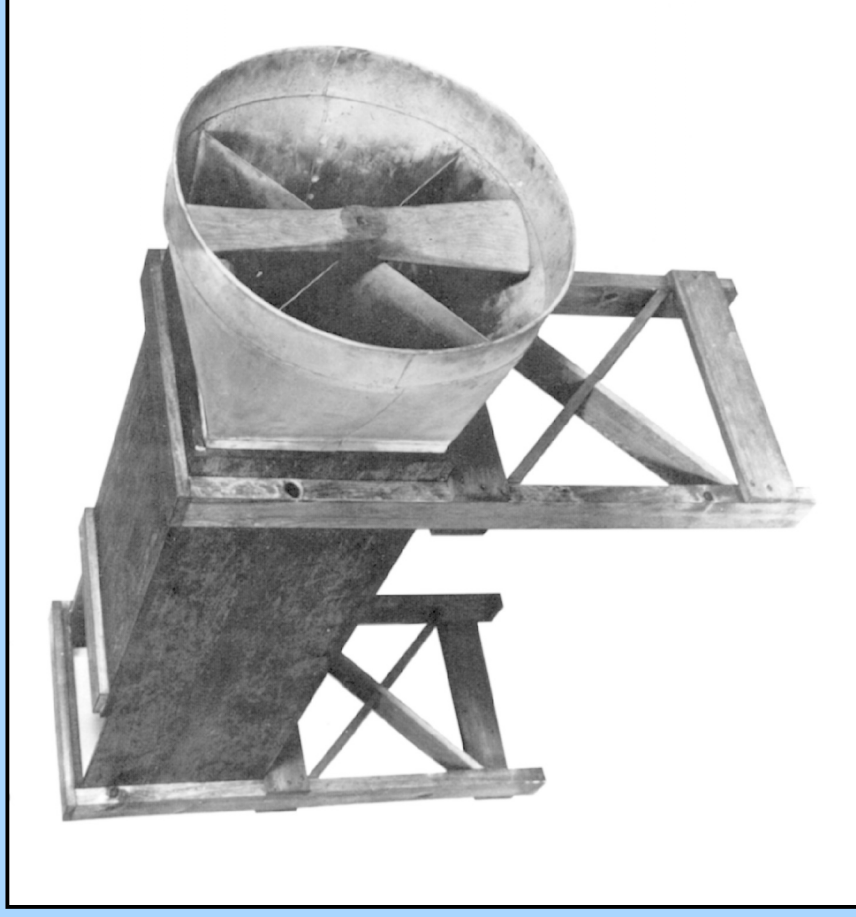
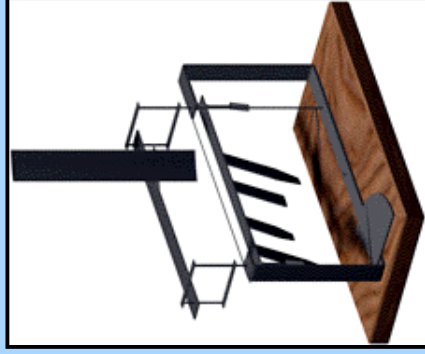
Dayton Experiments

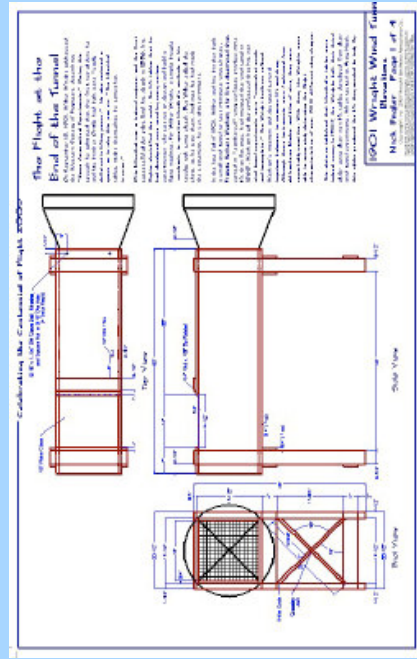
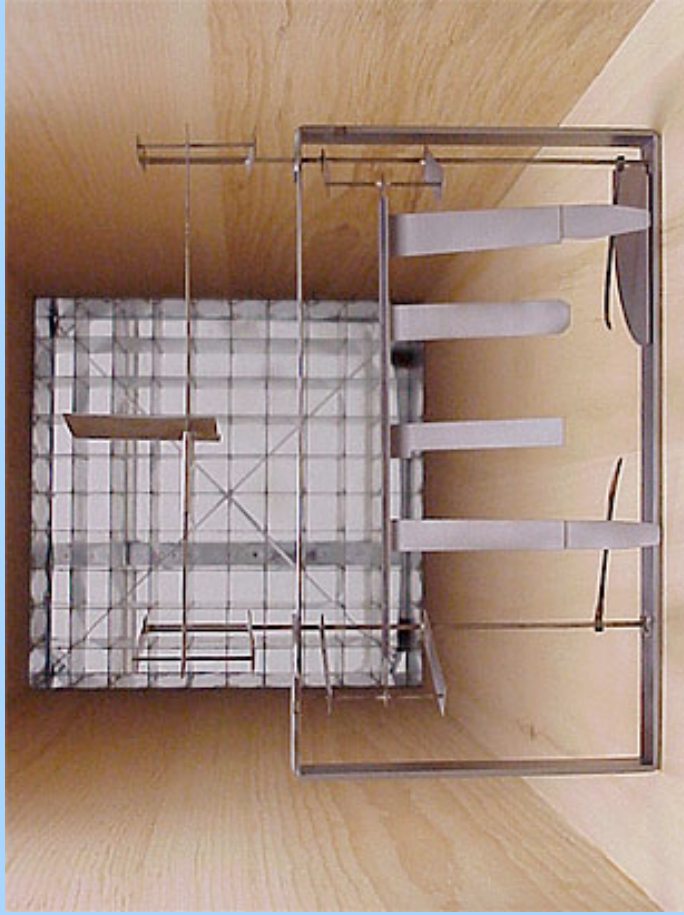
October 1901



1901 Wind Tunnel

16 inch square section x 6 feet





The flight at the

End of the Tunnel

On December 18, 1993, when Wright addressed the National Systems of Foresters, he said that "there is no national forest-management plan" because the "forest is not a thing, it is a process." He said that he would like to see a "Forest Land Management Policy" drafted and to be signed soon. "We should not wait until we have the map," he said.

space as the only thing that was "the finished
which, with a dimension for a person
to see it."

the same.²⁰

continued to play a vital role in the development of the country. The country's economic growth was rapid, and the country's political system was stable. The country's political system was stable, and the country's economic growth was rapid.

local shipping and access to and from existing markets.

Right now, says the study, a single female needs to lay 100 eggs to have a 50 percent chance of a grandchild. In the past, she would have had to lay 1,000 eggs.

There are some other people who are not as good as you are, but they are not as good as you are.

in the last fall of 1993, before another frost had a small and brief impact on the winter wheat.

¹ The authors would like to thank Dr. J. H. Koo for his assistance in the early stages of this work.

about 1000 years ago, and the first written record of the word "community" appears in the 13th century. The word "community" is derived from the Latin word "communitas," which means "shared" or "common." The word "community" is used in many different contexts, and its meaning can vary significantly depending on the context in which it is used. In this paper, we will explore the various meanings of the word "community" and discuss the challenges of defining it.

and found comparable results. "Numerical words and morphisms" by Benoit Vallée is devoted to the study of the structure of the morphisms of the free monoid on two letters, and this study is carried

It's not a movement, and this kind of word is important because in our society it's used a lot. Although there is a movement, we're talking about a religious belief, and that's what this movement is about.

[illegible]

ably be more widely distributed than (B) is, and may be as common as (B) in all the areas along the upper

the above is indicated, these subjects also had been previously exposed to the 1918 influenza pandemic, thereby decreasing the impact of the 1968 pandemic.

which means to write, i.e. to make a note. Thus, the
study notes *have* to be written, rather than *has*.
and travel arrangements, which is not said in 4, as that
the others produced the 4, then needed to look at

1900 WILSON ET AL.

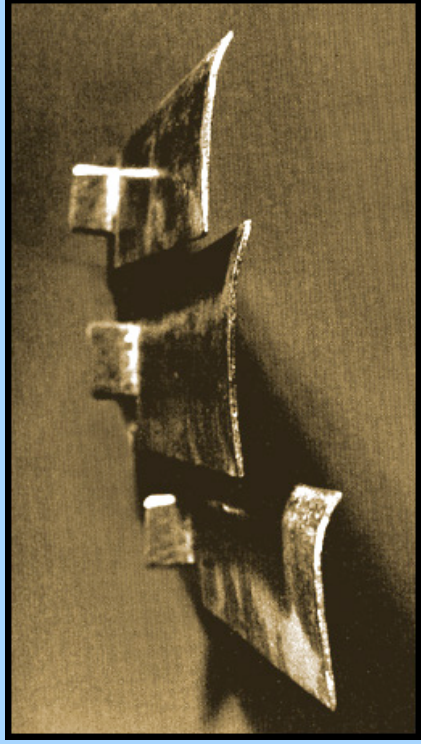
1901 Wright Wind
Measurements

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All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or by any information storage and retrieval system, without permission in writing from the copyright owner.

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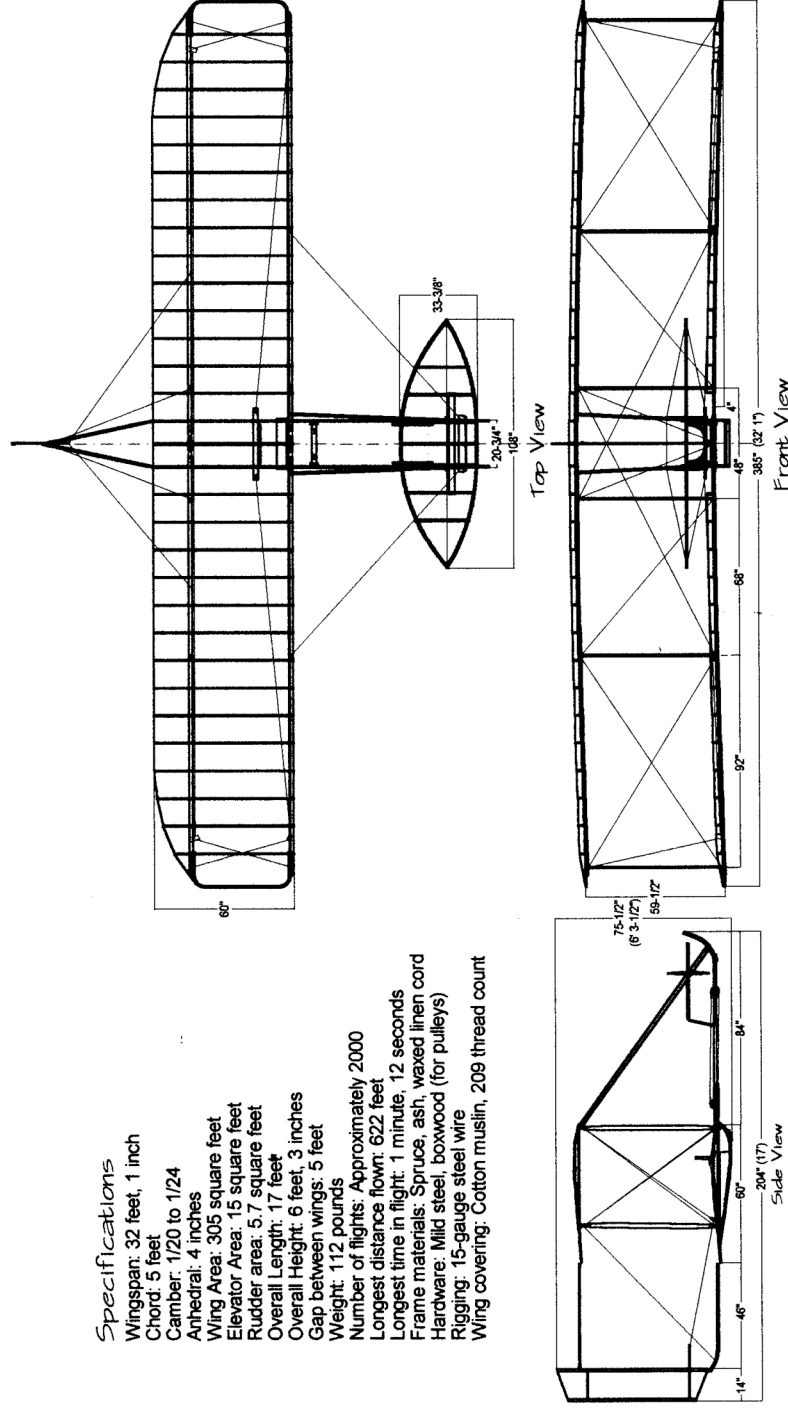
1901 Wright Wind Tunnel Results

A photograph of an open notebook with two pages visible. The left page is blank. The right page contains a large table of handwritten data. The table has multiple columns and rows, with some headings in bold or larger handwriting. The handwriting is in dark ink on aged, slightly yellowed paper. The notebook is bound in the center, and several other pages are visible underneath the top sheet.

1902 Wright Glider

Specifications

Wingspan: 32 feet, 1 inch
 Chord: 5 feet
 Camber: 1/20 to 1/24
 Anhedral: 4 inches
 Wing Area: 305 square feet
 Elevator Area: 15 square feet
 Rudder area: 5.7 square feet
 Overall Length: 17 feet
 Overall Height: 6 feet, 3 inches
 Gap between wings: 5 feet
 Weight: 112 pounds
 Number of flights: Approximately 2000
 Longest distance flown: 622 feet
 Longest time in flight: 1 minute, 12 seconds
 Frame materials: Spruce, ash, waxed linen cord
 Hardware: Mild steel, boxwood (for pulleys)
 Rigging: 15-gauge steel wire
 Wing covering: Cotton muslin, 209 thread count



Not for sale or profit; these plans are to be distributed freely and free of charge.

To help celebrate the upcoming Centennial of Flight in 2003, the Wright Brothers Aeroplane Company offers the engineering drawings we developed for the 1902 Wright Glider free. This is a wonderful project not just for those who enjoy building historic aircraft, but also for young people. If you're a teacher or a youth leader, there is no need to pay for these plans. We encourage you to use them in your classroom or youth group. However, remember these are copyrighted plans and the copyright holder claims all privileges and protection afforded by law. If you use or distribute these plans, you are bound to these conditions: 1. You may not sell or profit from these plans. 2. You cannot charge copying, handling, postage, or shipping fees.

1902 Wright Glider
 Elevations
 Nick Engler Page 1 of 20
 Copyright © 2000 Wright Brothers Aeroplane Co.
 1000 Wright Brothers Ave., Dayton, OH 45325
 www.wrightbrothers.org

1902 Wright Glider

- Span: 32 feet 1 inch
- Chord: 5 feet
- Gap: 4 feet, 7 inches
- Camber $1/24$
- Wing Area: 305 sq ft
- Horizontal Rudder Area
15 sq ft
- Length 16 feet 1 inch
- Weight 112 lb
- Three configurations

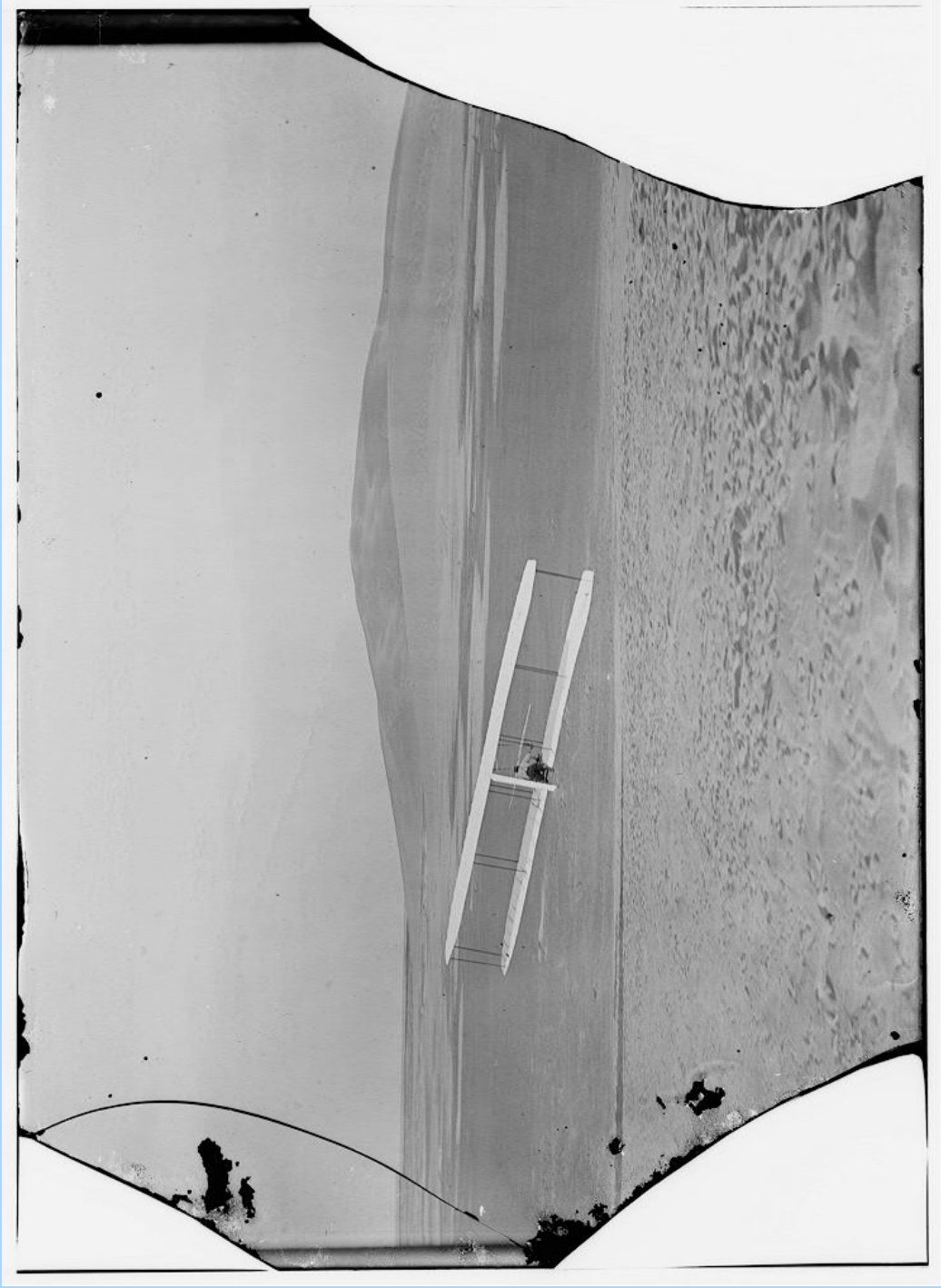


1902 Wright Glider

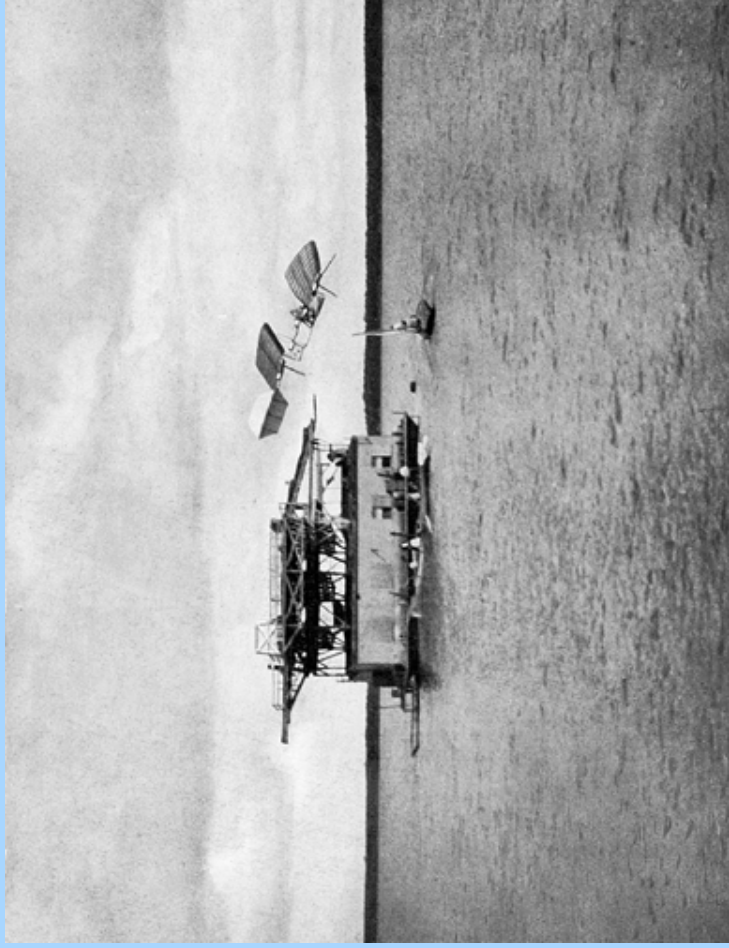


Centennial of Controlled Flight

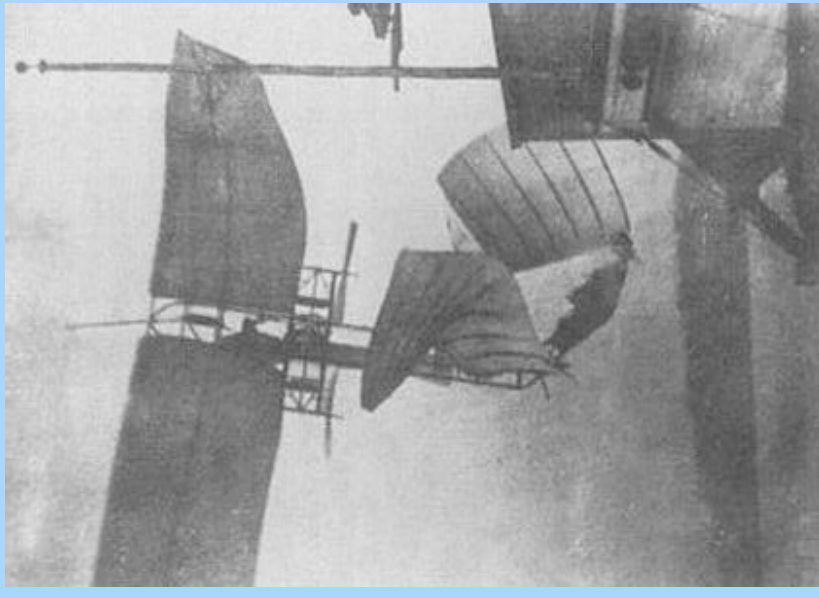
24 October 1902



1903 Langley Aerodrome



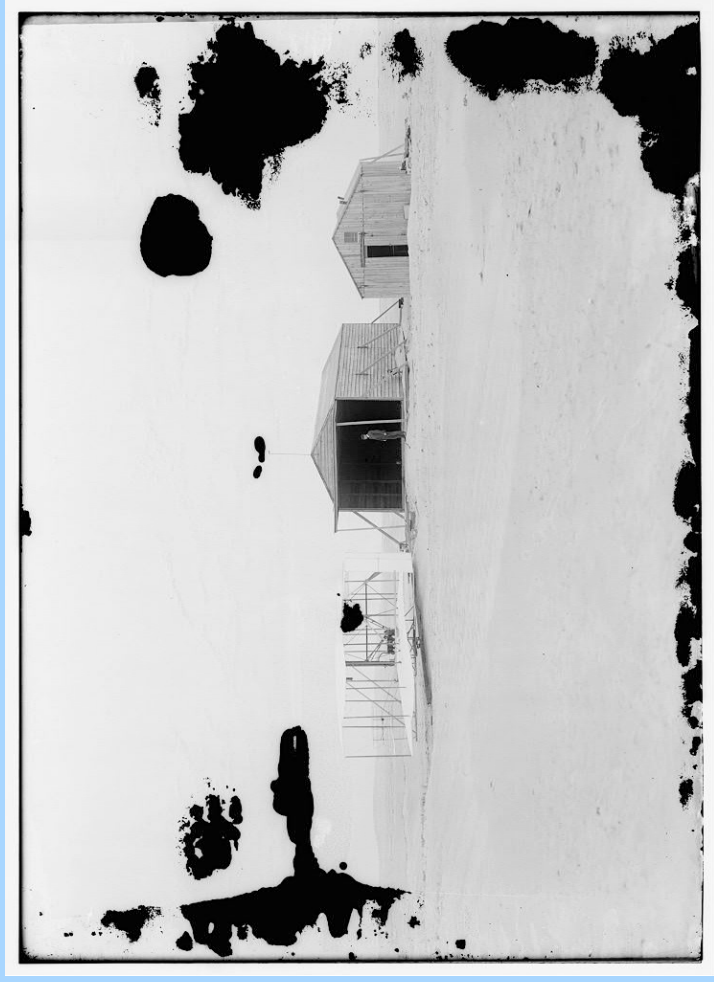
Oct 7, 1903



Dec 8, 1903

1903 Wright Flyer

- Span: 40 feet 4 inch
- Chord: 6 feet 6 inches
- Gap: 6 feet 2 inches
- Camber $1/20$
- Wing Area: 510 sq ft
- Horizontal Rudder Area
48 sq ft
- Vertical Rudder 21 sq ft
- Length 21 feet 1 inch
- Weight 605 lb



1903 Wright Flyer

December 14, 1903



Wilbur wins the coin toss, and...

1903 Wright Flyer

December 14, 1903



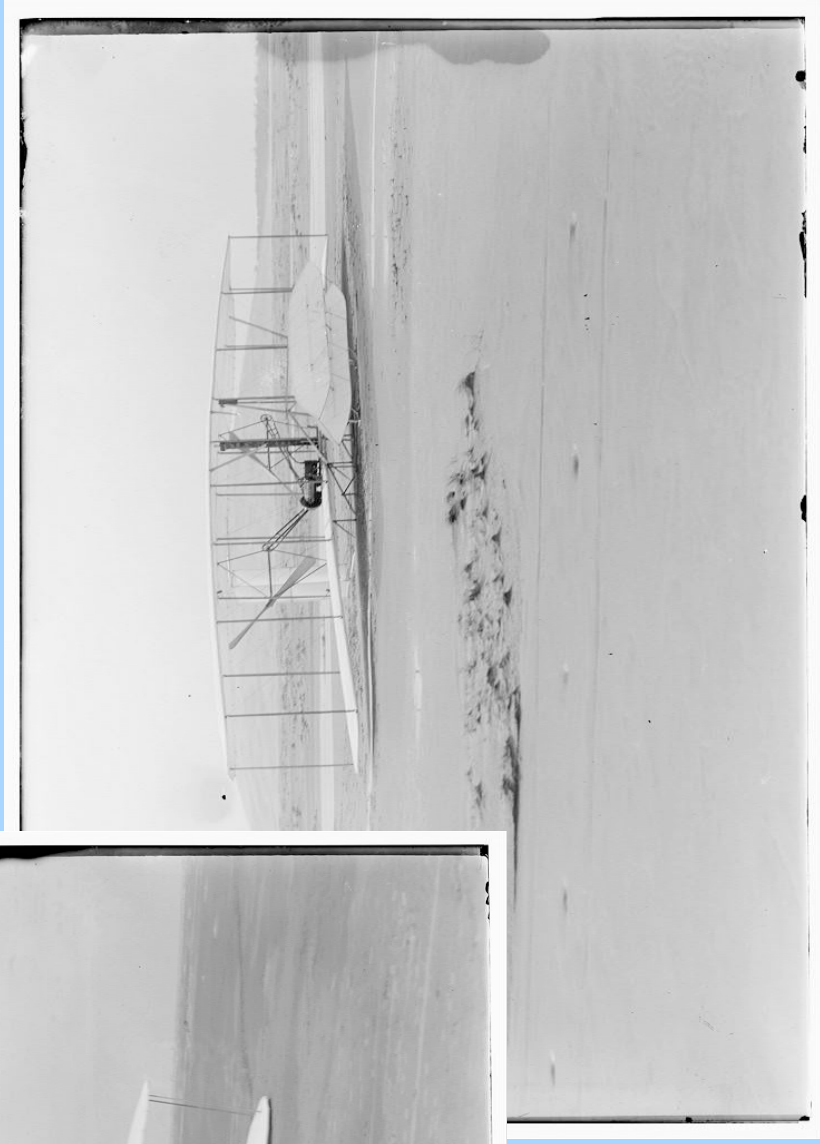
Oops!

1903 Wright Flyer

December 17, 1903



1903 Wright Flyer



They tell the world...

Form No. 108.

THE WESTERN UNION TELEGRAPH COMPANY.
23,000 OFFICES IN AMERICA. INCORPORATED
CABLE SERVICE TO ALL THE WORLD.

This Company TRANSMITS and DELIVERS messages only on conditions limiting its liability, which have been accepted to be the sender of the following messages. Errors can be guarded against only by repeating a message back to the sending station for comparison, and the Company will not hold itself liable for errors or delays in transmission or delivery of Unrepeated Messages, beyond the amount of tolls paid thereon, nor in any case where the claim is not presented in writing within sixty days after the date of transmission. This is an UNREPEATED MESSAGE, and is delivered by request of the sender, under the conditions named above.

ROBERT G. CLOWRY, President and General Manager.

RECEIVED at

170

176 C KA GS 33 Paid. Via Norfolk Va

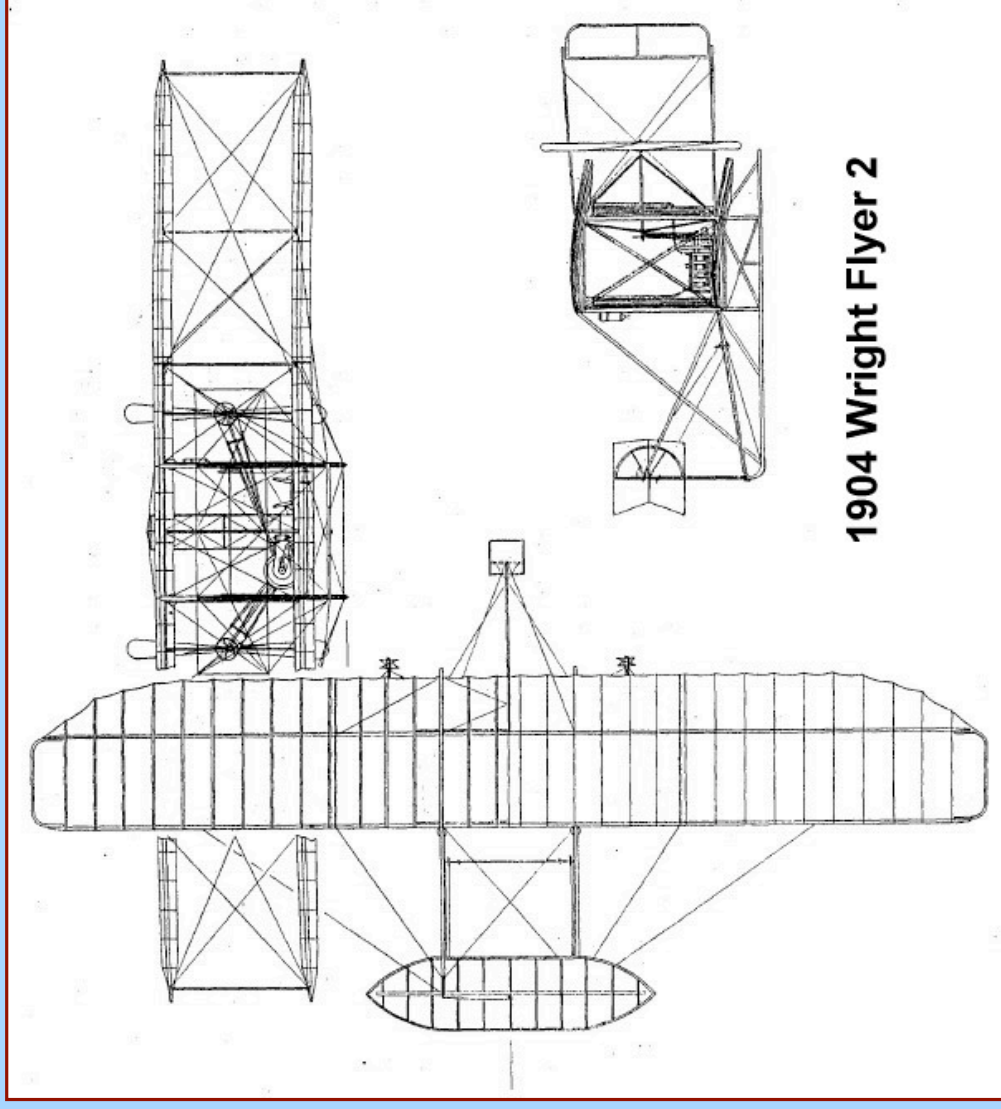
Kitty Hawk N C Dec 17

Bishop M Wright

7 Hawthorne St

Success four flights Thursday morning all against twenty one mile
wind started from level with engine power alone average speed
through air thirty one miles longest 57 seconds inform Press
home ~~Christmas~~ Christmas. Orevelle Wright 525P

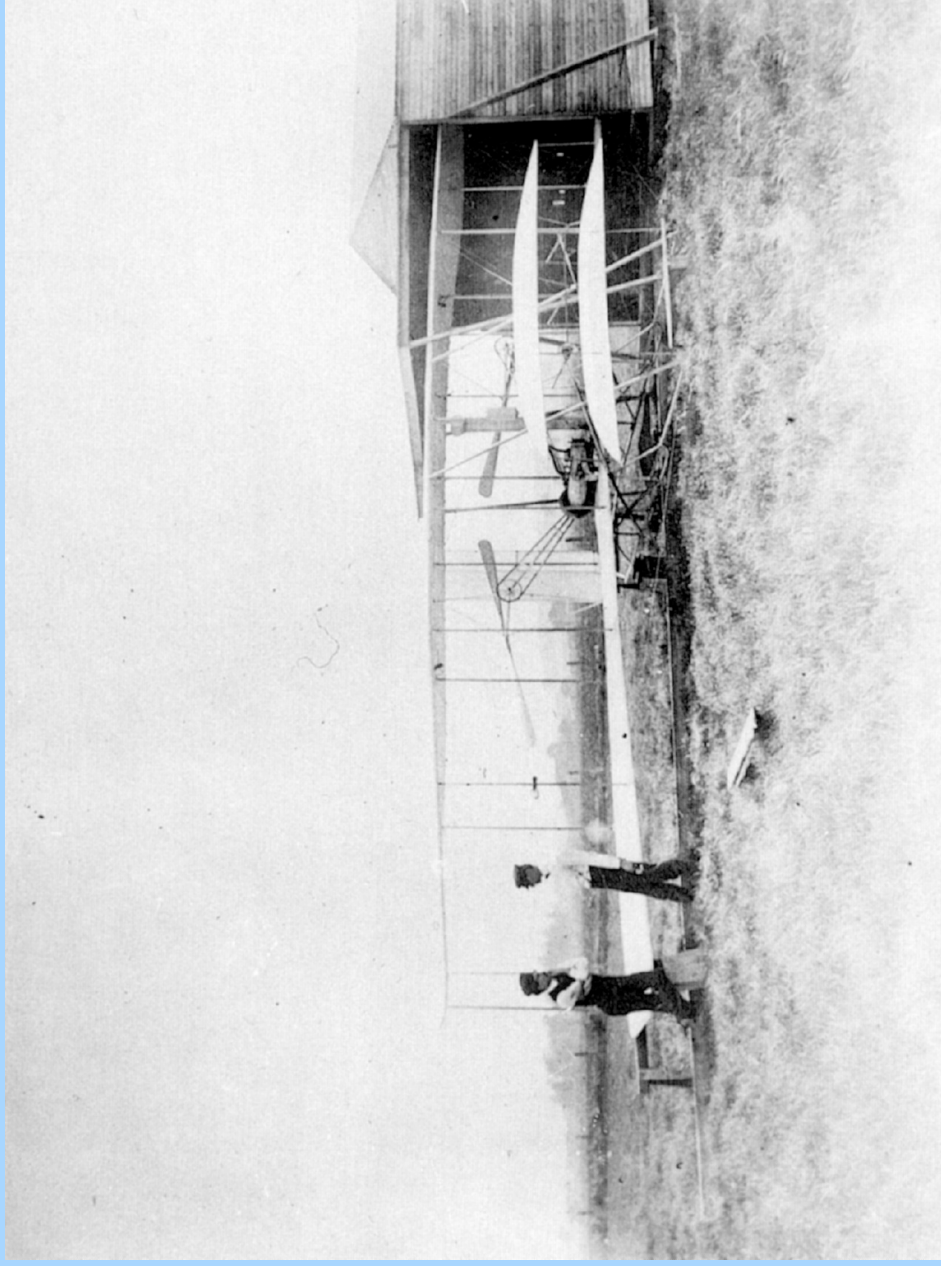
1904 Wright Flyer



1904 Wright Flyer 2

1904 Huffman Prairie Ohio

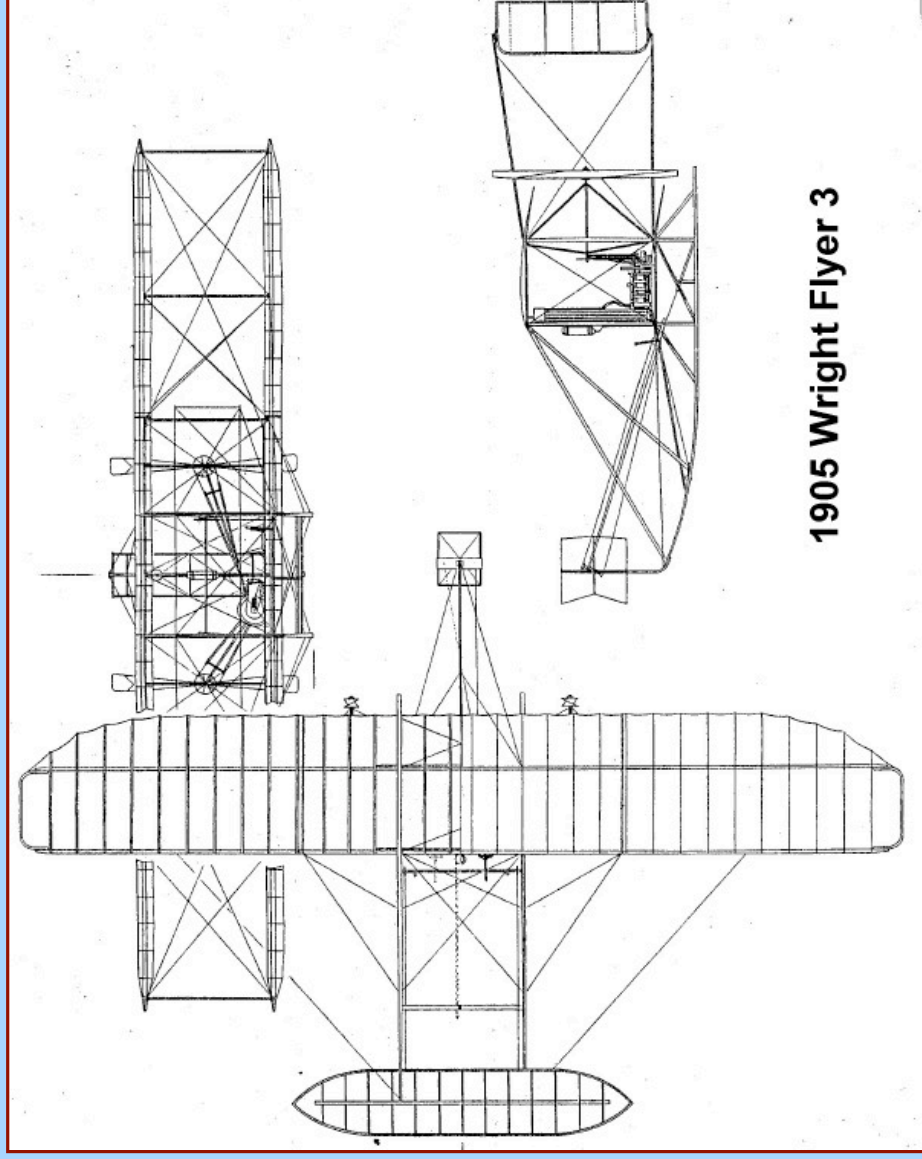
September 20, 1904 First Complete Circle in an Airplane



1904 Wright Flyer III



1905 Wright Flyer



1905 Huffman Prairie OH

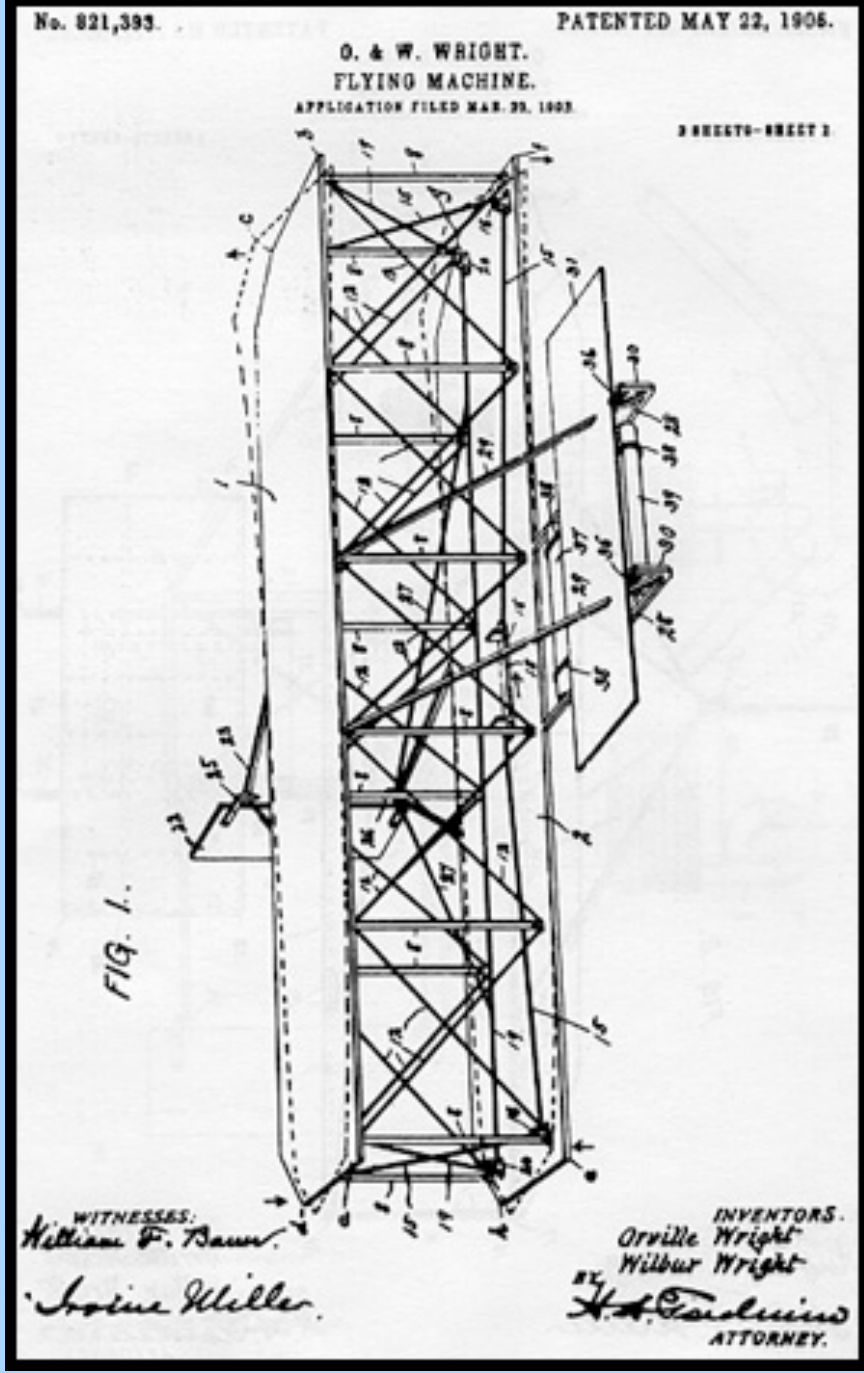
Oct 4, 1905 Extended Flight in an Airplane (38 minutes)



Wright Flying Machine Patent

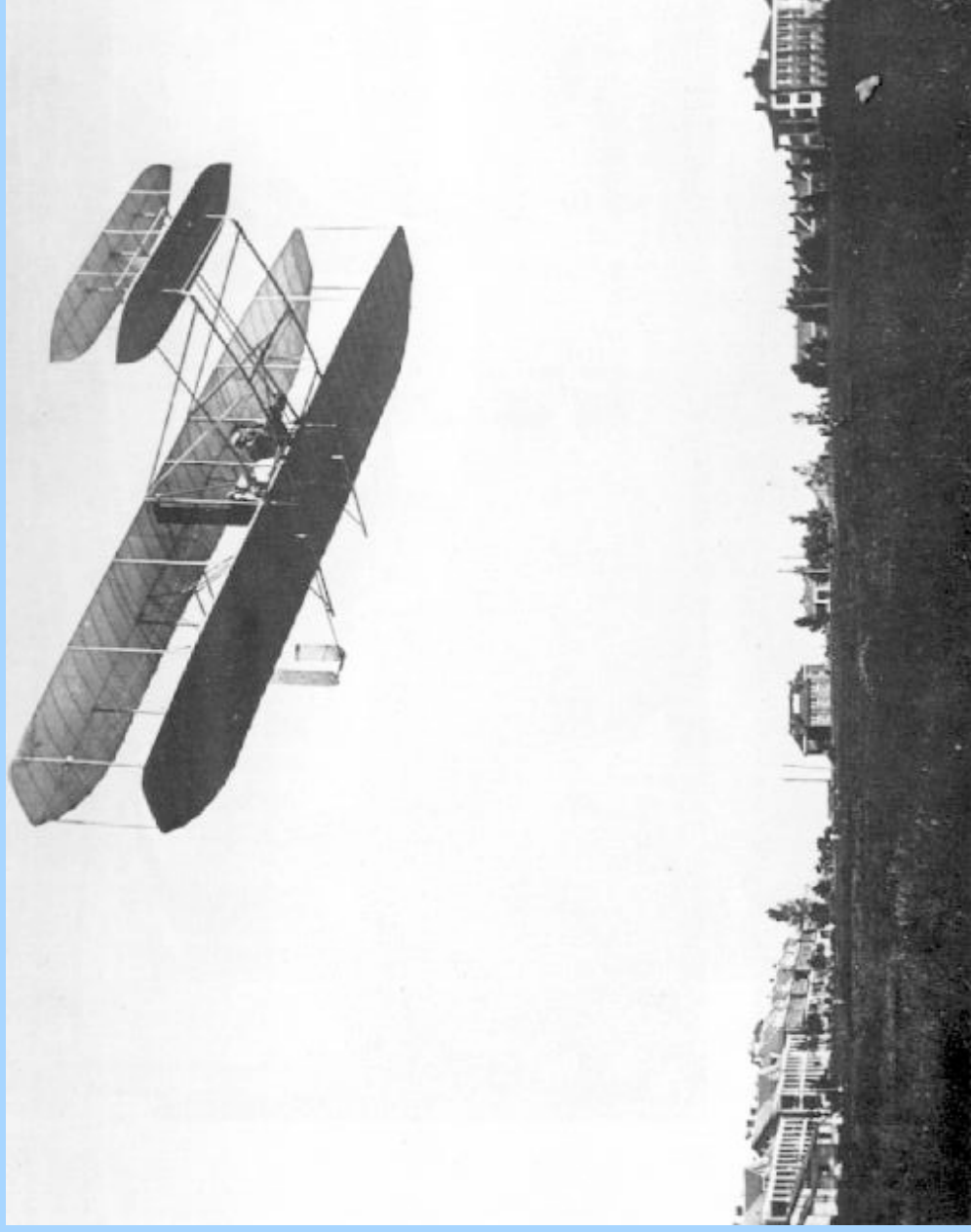
#821,393

May 22, 1906



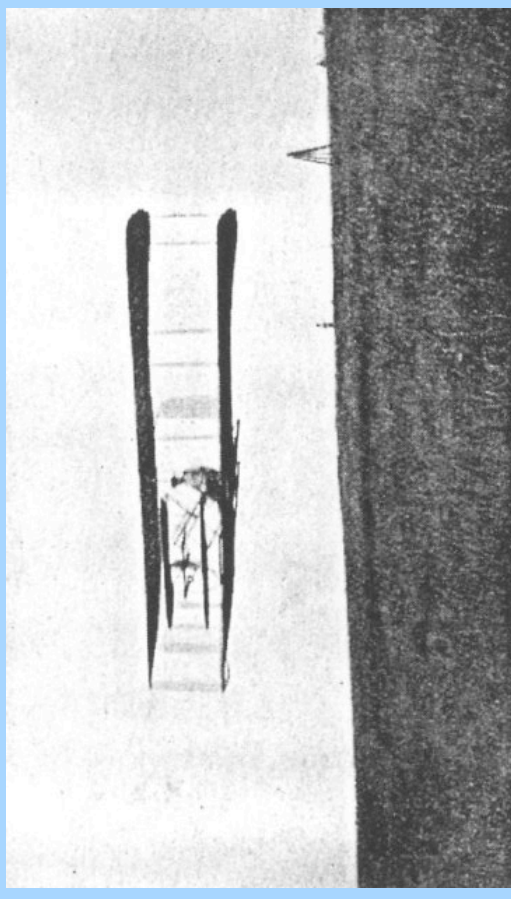
1908-1909 France & Virginia

Public trials of the first practical airplane



1909 Clarke-Wright Glider

- Built as a trainer to Wright specs



1911 Wright Glider

- Built for autopilot experiments
- Set duration record (9 min 45 sec)



The Rest is History...

- 1904 Flights of 5+ minutes duration
- 1905 Flights to 38 minutes duration
- 1906 - 1907 Commercialization
- 1908 - 1909 Flight Demonstrations
 - Wilbur in France, Italy and Germany
 - Orville in United States
- 1909 The Wright Company is established
 - Clarke-Wright glider in England
 - Established Flying School in Alabama, OH
- 1911 Glider Experiments with autopilot
- Orville serves on NACA board from 1920 to 1948



NACA Board, 1938

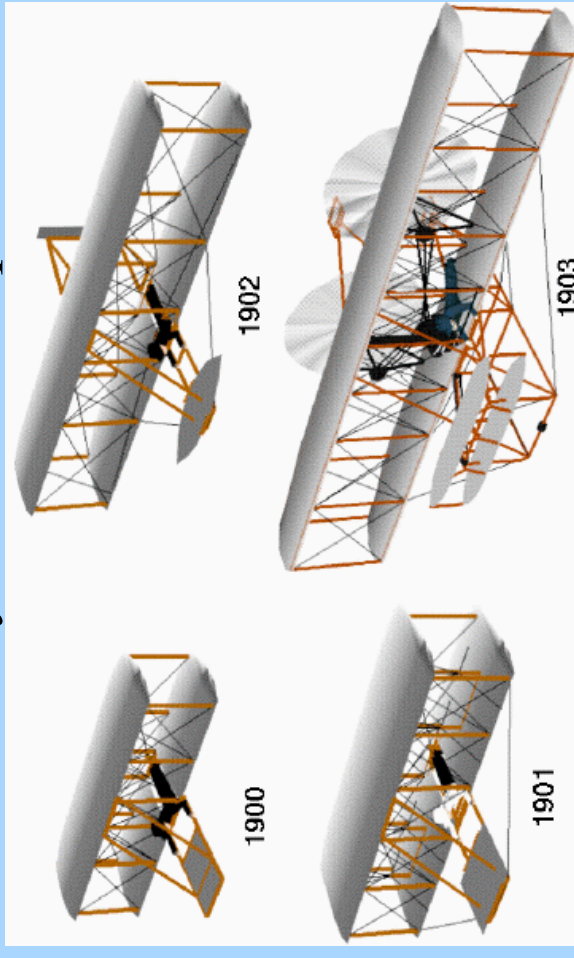
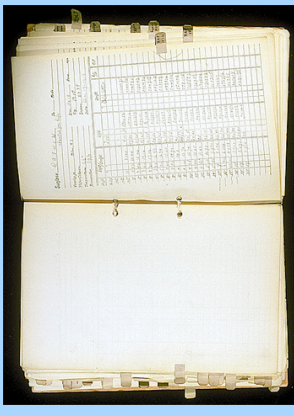
What Does Flight Research Accomplish?

- Separates the Real from the Imagined
- Uncovers the Unexpected and the Overlooked
- Forces the Realistic Integration of the Pilot
- Forces the Development of Reliable Prediction and Test Processes
- Requires Every Problem to Be Addressed
- Promotes Technology Transfer
- Builds a Core Technical Team

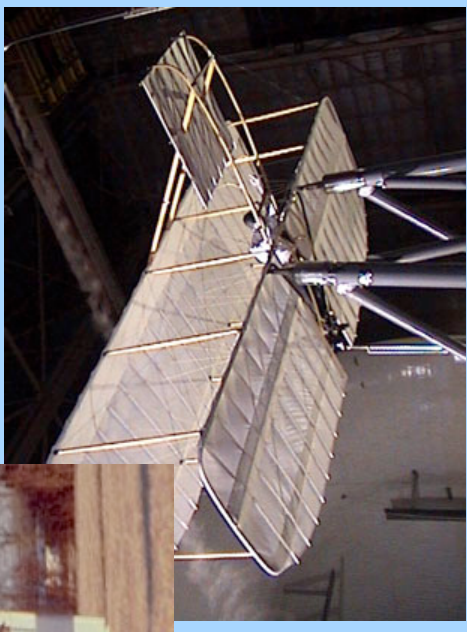
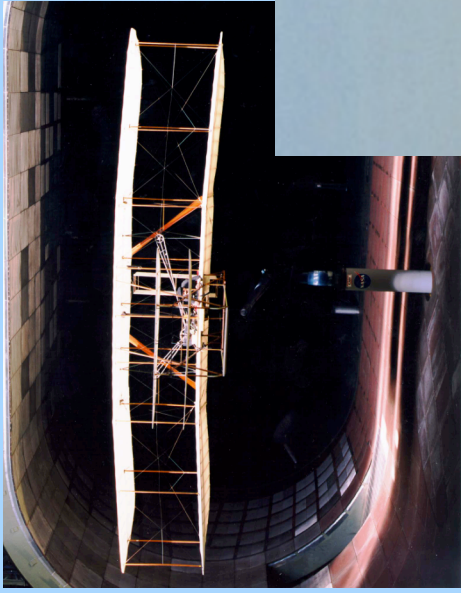
Flight Research Lessons Learned

Then...Still Apply Today

- Make sure you really understand the problem
- Do a literature search and read and talk
- Plan carefully...and record as much as possible
- Identify and measure your most important parameters
- Plan for the unexpected...and expect differences
- Test over a large envelope but not necessarily a full envelope
- Fly early, as much as possible
 - more visibility
 - more attention to “Real” problems
 - much more credibility
 - faster technology transfer
- *Get a simulation going ASAP*



Understanding the Wright's Accomplishments Through Evaluation



Wright Flyers Today



1903 Wright Flyer I
National Air & Space Museum



1905 Wright Flyer III
Carillon Hall



Orville Wright
**HOW WE INVENTED
THE AIRPLANE**
An Illustrated History

Edited, with an Introduction and
Commentary, by Fred C. Kelly
Additional Text by Alan Weissman
With 76 Photographs



New in paperback

*A
Dream
of Wings*

Americans
and the Airplane,
1875-1905

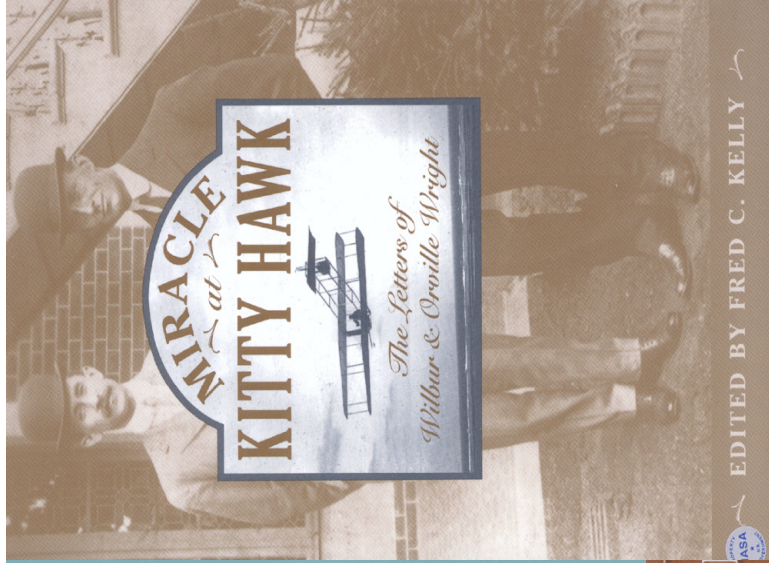
Tom D. Crouch

*The PIONEER
of FLIGHT*

A Documentary History

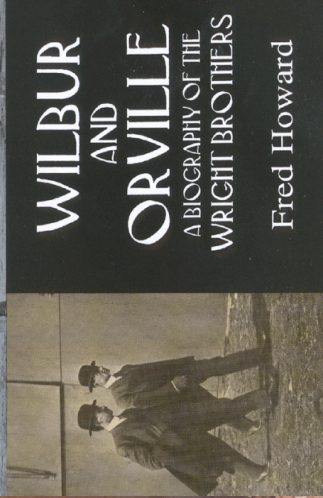


PHIL SCOTT



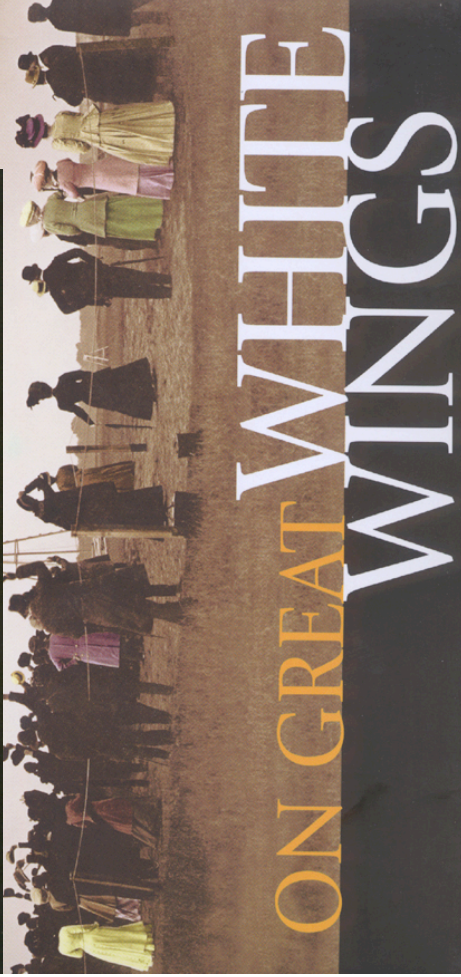
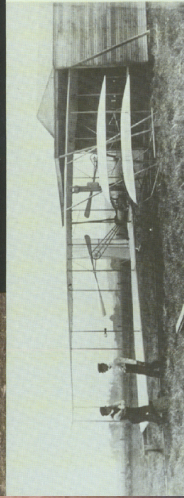
**MIRACLE
at
KITTY HAWK**
*The Letters of
Wilbur & Orville Wright*

EDITED BY FRED C. KELLY



**WILBUR
AND
ORVILLE**
A BIOGRAPHY OF THE
WRIGHT BROTHERS

Fred Howard



ON GREAT **WINGS**

THE BISHOPS

A Life of
Wilbur and
Orville Wright

BOYS

Tom Crouch

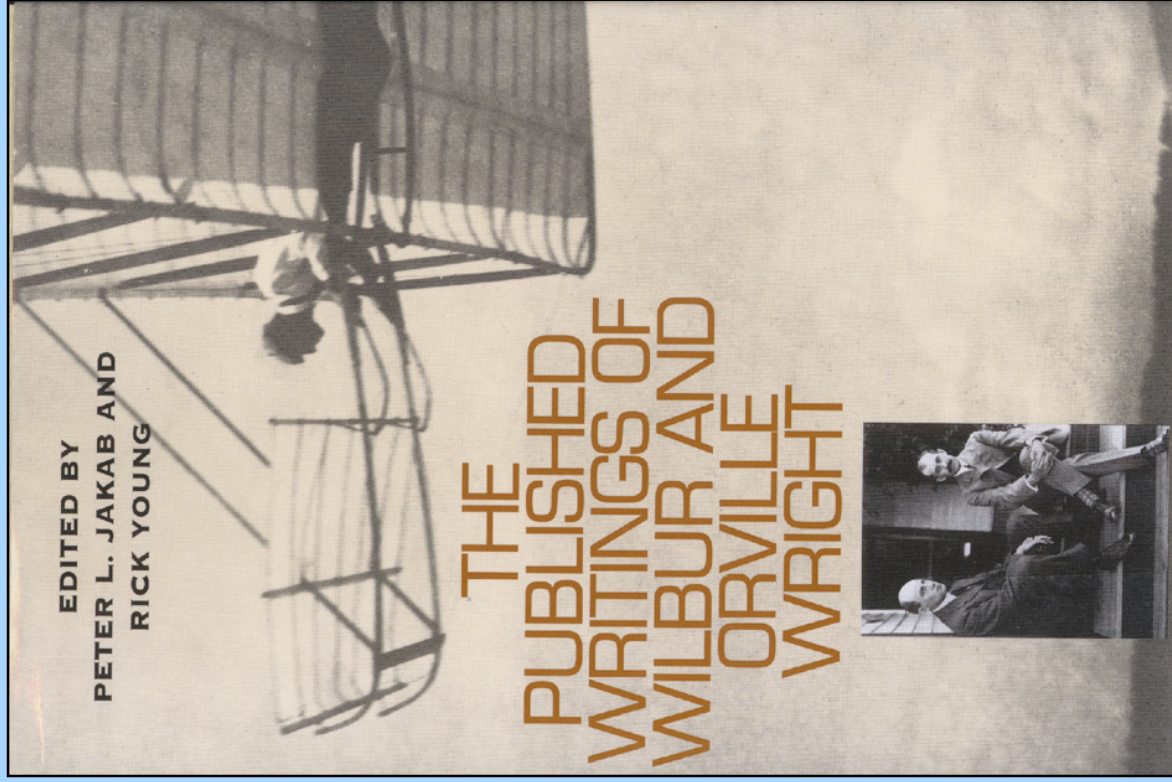
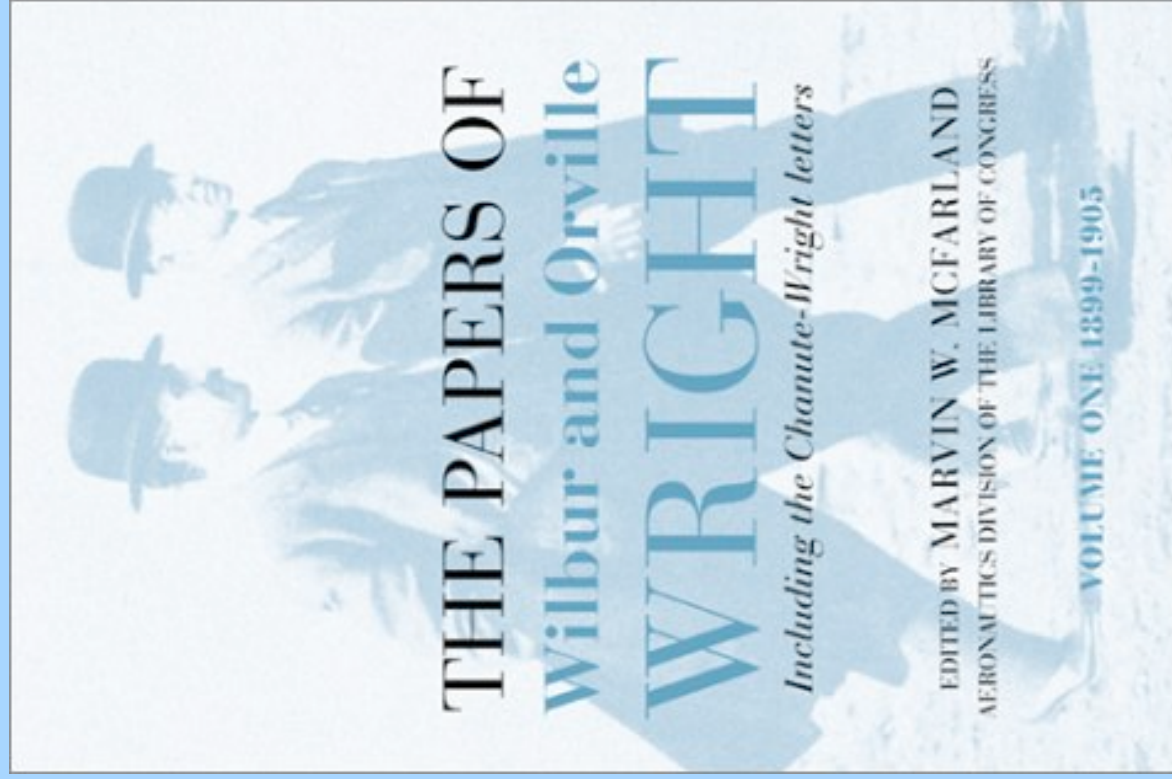


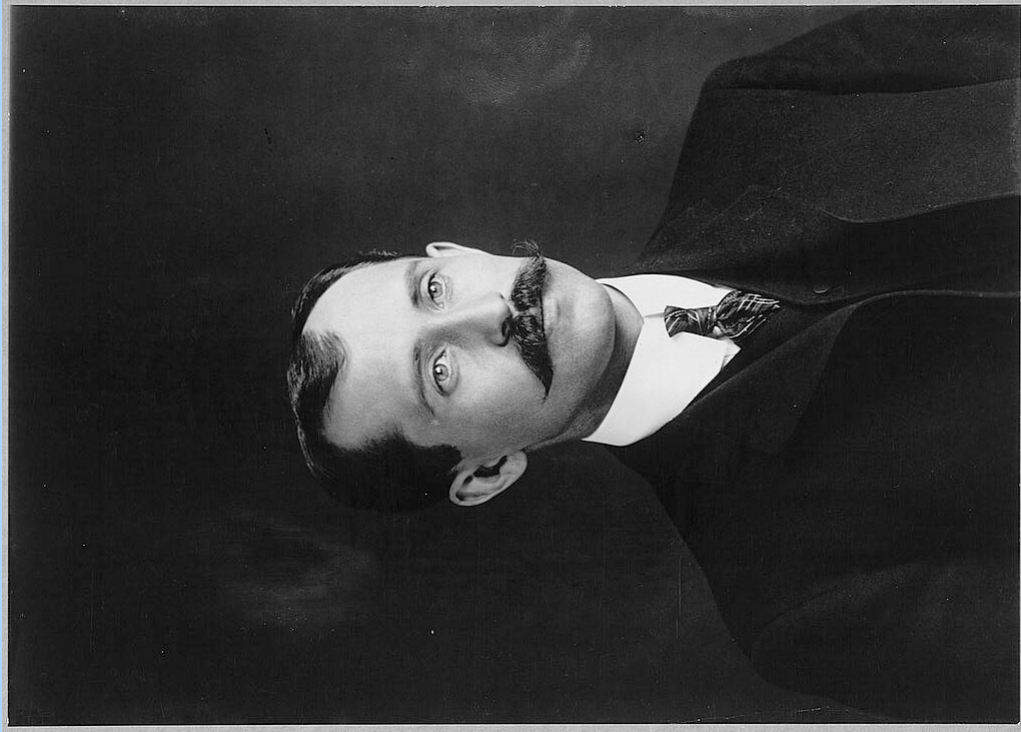
VISIONS OF A FLYING MACHINE

The Wright Brothers and the
Process of Invention

Peter L. Jakab







Orville Wright



Wilbur Wright

Orville's Camera: 1902 to 1905

